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Agricultural structures of Poland and Turkey and analysis of agricultural mechanization levels with statistical methods comparatively

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Abstract: *Agricultural structures of Poland and Turkey and analysis of agricultural mechanization levels with statistical methods comparatively.* Agriculture sector has generally important place in national economies due to some reasons like supplying food needs of increasing population, supplying raw material for industry and providing employment in rural areas. Importance of agriculture in Turkey's social and economic structure has especially been increasing due to convenience of field and climate advantages. Making use of agricultural mechanization as optimum is important for using these advantages and more profitable production. This will provide to make agricultural processes with the highest capacity on time. However, it should be taken into consideration that we have to choose and use the best method of agricultural mechanization because it generates high cost and energy nowadays. In this article, it is targeted to examine the agricultural mechanization levels of Poland and Turkey which have similar agricultural structures comparatively with statistical tools and this paper focuses on the results of research done on agricultural machinery usage and market in Poland and Turkey. The research is also important because it recognizes the relations between agricultural machinery sector and its macro environment and helps to explain things that should be done while forming the strategy.

Key words: agriculture, mechanization, statistical analysis

INTRODUCTION

Agriculture sector and agricultural mechanization level in Turkey

Turkey is a big agriculture country with wide product range and climate advantages. It has an important place in the world with grain, leguminous plants, fruit, vegetable production and husbandry activities. In spite of these advantages it can't be said that Turkey can exactly use its potential. There are some challenges and farmers continue their search for ways of improving and enhancing production efficiency due to economic and environmental constrains [Evrenosoğlu and Borowski 2014]. Not being able to use agricultural mechanization as optimum and having small family businesses rather than big holdings can be counted among the challenges. The basic indicators of agriculture volume of Turkey are given in Table 1.

The values in Table 1 show that share of agriculture in Turkey is quite high. Some indicators which show the level of agricultural mechanization that provide opportunity of using new and advanced

TABLE 1. Basic agricultural indicators of Turkey (Structural changes reforms on Turkish agriculture. 2013 report of FALM)

Indicator	2002			2012		
Basic indicators	total of Turkey	total of Turkey's agriculture	share of Turkey's agriculture [%]	total of Turkey	total of Turkey's agriculture	share of Turkey's agriculture [%]
Population (in millions)	69.3	23.7	34.2	75.6	17.2	22.7
Employment (in millions)	21.3	7.4	34.9	24.8	6.1	24.6
National income (in billions) [USD]	230.5	23.7	10.3	786.3	62.5	7.9
GDP per capita [USD]	3 492.0	1 064.0	28.6	10 504.0	3 622.0	34.5
Exportation (in billions) [USD]	36.0	4.0	11.2	152.5	16.0	10.5
Importation (in billions) [USD]	51.5	3.9	7.7	236.5	16.3	6.9

production techniques can be seen for Turkey and European Union in Table 2.

The parameters in Table 2 show the development in general agriculture level at the same time. When the values are analyzed from this aspect it is understood that agricultural mechanization level and development in agriculture has remained below the values of European Union. It is important that development in agricultural engineering resulting in the occurrence of new implements and

TABLE 2. Comparison of agricultural sector between Turkey and European Union (Özgüven et al. [2010])

Indicator	Turkey	European Union
Number of agricultural enterprises	3 000 000	13 700 000
Average size of agricultural enterprises [ha]	6	15.8
Total arable land and area under permanent crops [ha]	26 672 000	171 878 000
Equipment weight per tractor [t]	4.2	12
Number of equipment per tractor	5.2	10
Number of tractors per 1 000 ha	38	89
Cultivated area per tractor [ha]	26	11.3
Number of tractors	1 000 000	15 000 000
Average tractor power [kW]	60	100
Tractor power per 1 ha [kW]	1.68	6

machines of big working width and productivity enables to apply modern technologies of plant cultivation [Buliński and Niemczyk 2011]. However, choosing the suitable mechanization method and using the tractors with machine and equipment which are in suitable size will play important role in energy consumption and cost.

Agriculture sector and agricultural mechanization level in Poland

Poland takes part in Central Europe with important area, population and economic potential and its importance and share in world economy has been rising because of the increase in the gross domestic product (GDP). In Polish economy 4% of GDP is coming from agriculture sector. Although this rate is seen low, the social and politic weight of agriculture sector continue in the country. Poland is ranked at six position among the EU countries in agricultural activities [Gajownik-Łazuga and Gajownik 2014]. Poland is also an important producer in some crops in the world and Europe. It is in the first rank in apple production in Europe and in the second rank in rye and raspberry production in the world and Europe. On the other hand, it takes place in the first 10 rank in the production of potatoes, strawberry, onion, sugar beet, wheat, milk and pork in the world and Europe [Bektaşoğlu 2011].

Agricultural areas and the structure of agricultural businesses for Poland, Turkey and some European Union countries are given in the Table 3. Selected countries having large agricultural area are shown in Table 3. These indicators demonstrate that Poland and Turkey have similar structures in point of agricultural area and GDP per capita. In this sense, comparing two countries and determining the differences and their reasons in

TABLE 3. Comparison of Poland with some other EU countries and Turkey in point of selected agricultural indicators in 2012 (Statistical yearbook of agriculture for 2013[1] , Turkish Statistical Institute[2] database, Uzundumlu [2012][3])

Countries	Total Area [1 000 ha]	Agricultural cultivated area [1 000 ha]	Number of agricultural businesses [1 000 pcs]	Average size of agricultural businesses [ha]	GDP per capita [USD]*
Poland[1]	31 267	14 969.20	1 477.80	10.12	14 343
Turkey[2]	78 356	15 463.37	3 076.64	5.02	10 515
France[3]	55 150	27 476.93	527.35	52.10	42 732
Germany[3]	35 703	16 931.90	370.48	45.70	47 822
Italy[3]	30 134	12 744.20	1 679.44	7.59	34 908
Romania[3]	23 839	13 753.05	3 931.35	3.50	9 996
Spain[3]	50 537	24 892.52	1 043.91	23.85	29 767
England[3]	24 361	16 130.49	299.83	53.80	46 332

*GDP per capita in 2014 according to the World Bank.

agricultural mechanization level will be meaningful.

Tractor and some agricultural machine and equipment existence in point of agricultural mechanization for Turkey and Poland are given in the Table 4 and Figure. In the light of information in Table 4 and Figure, it is seen that the existence of tractor and some agricultural machines in Poland is much more than Turkey although both countries have the similar arable area and average field size. When the agricultural machine and equipment numbers are analyzed with production amounts, Poland has 2.1 sugar beet harvester per 1,000 t product while Turkey

TABLE 4. Change in the existence of tractor and some agricultural machines in Turkey (Turkish Statistical Institute [2014])

Type of Machines	2010	2011	2012	2013	2014
Tractors	1 096 683	1 125 001	1 178 253	1 213 560	1 243 300
Combine harvester	13 799	14 313	14 813	15 486	15 899
Sugar beet harvester	18 021	18 896	19 673	20 413	205 07
Potato harvester	19445	15 117	21 015	20 658	21 222
Forage harvester	3 471	3 778	3 917	4 248	4 674
Sprayers	278 761	291 505	305 295	312 651	322 174

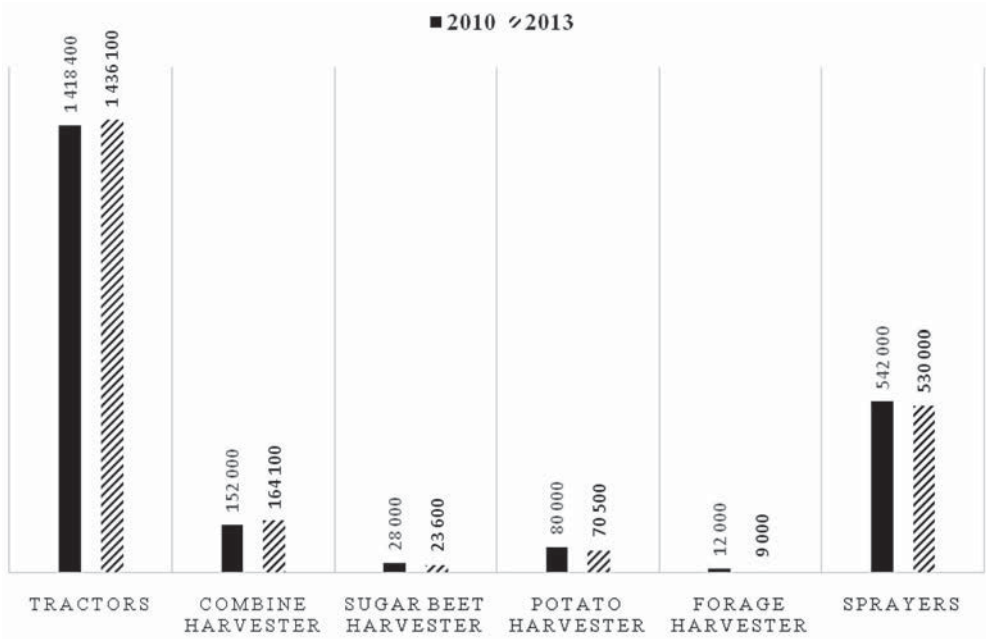

FIGURE. Change in the existence of tractor and some agricultural machines in Poland (Central Statistical Office of Poland [2014])

has 1.2 sugar beet harvester per 1,000 t product with 2013 data. In addition to this Poland has 9.9 potato harvester per 1,000 t product while Turkey has 5.1 potato harvester per 1,000 t product. There is nearly twice the difference in spite of similar production amount. One of the reasons for that can be decreases in the sown areas in Poland due to the EU regulations. The main reason for Turkey can be that manpower usage in some regions in Turkey is still going on even if mechanization is increasing in recent years.

It can be said that financial resources provided by European Union to Poland and attempts towards decreasing agricultural population in Poland are also effective in this situation. In Poland the significant share of combine harvester in agricultural machines is also easy to observe. In modern farming, a combine harvester is as essential as a tractor [Gaworski et al. 2015]. Similarly the supply and registrations of tractors after Poland's accession to the EU increased significantly. The results of study on the Central Statistical Office (GUS) data showed that within years 2005–2010 the farmers purchased in total 184.3 thousand tractors, 28.6% (52.8 thousand) the brand-new tractors inclusive [Pawlak 2014]. But it would be useful to examine the subject in point of usage of suitable tractor and machine combination in accord with field size for productivity. In this sense, statistical analysis of relations between an important agricultural mechanization indicator (tractor motor power per 100 ha), gross value added from agriculture and agricultural employment rate in total employment will be done.

The basic values for statistical analysis for Turkey and Poland are given in Tables 5 and 6.

TABLE 5. Some values of Turkey for statistical analysis (Hatunoğlu and Eldeniz [2012][1] , Turkish Statistical Institute database [2011][1] , Ağcı [2002][2], Özgüven et al. [2010][2], Korucu et al. [2015][2], Demirok [2014][3]

Year	Gross value added (in millions) [EUR][1]	Tractor motor power per 100 ha [kW][2]	Share of agricultural employment in total employment [%][3]
2000	29 000	123.0	36.0
2005	36 574	197.0	25.7
2010	46 837	218.0	25.2

TABLE 6. Some values of Poland for statistical analysis (Index Mundi [2013][1], Lisowski [2012][2], http://www.statista.com/statistics/376395/employment-by-economic-sector-in-poland/[3])

Year	Gross value added [million EUR][1]	Tractor motor power per 100 ha [kW][2]	Share of agricultural employment in total employment [%][3]
2000	5 447	225.7	18.8
2005	7 120	355.1	17.4
2010	9 403	355.6	12.8

MATERIAL AND METHODS

Basic data for statistical analysis was taken from various scientific articles, Turkish Statistical Institute and Central Statistical Office of Poland database. Tractor motor power per 100 ha including the knowledge of tractor number per agricultural unit area and average tractor motor power was used as the indicator of agricultural mechanization level. A desk research was run by using secondary data and the analysis of this data was done statistically by using SPSS package software.

Pearson correlation was used in the statistical analysis of variables and Pearson correlation coefficient was calculated by using following equation [Parlińska et al. 2010].

$$r = \frac{\Sigma XY - (\Sigma X)(\Sigma Y)/n}{\sqrt{\Sigma\left(X^2 - (\Sigma X)^2/n\right)\left(\Sigma Y^2 - (\Sigma Y)^2/n\right)}} \quad (1)$$

For hypothesis control, null hypothesis was constructed like given in equation 2 and alternative hypothesis was constructed like given in equation (3) [İkiz et al. 2006].

$$H_0{:}\rho = 0 \text{ (there is no correlation)} \quad (2)$$

$$H_1{:}\rho \neq 0 \text{ (there is correlation)} \quad (3)$$

The standard deviation of r value for hypothesis control was calculated via equation (4) and t-statistics was calculated by using this via equation 5 [Zimmerman et al. 2003].

$$s_r = \sqrt{\frac{1-r^2}{n-2}} \quad (4)$$

$$t = \frac{r}{s_r} \quad (5)$$

where:
r – correlation coefficient;
X – independent value;
Y – dependent value;
H_0 – null hypothesis;
H_1 – alternative hypothesis;
ρ – correlation coefficient of population;
s_r – standard deviation of r;
t – t-statistics;
n – number of observations.

RESULTS AND DISCUSSION

Pearson correlation analysis for Turkey's data in Table 5 was done in order to determine the relation between the gross value added and the tractor motor power per 100 ha as the indicator of agricultural mechanization and Pearson correlation coefficient was calculated as 0.9 via equation (1) and the correlation table can be seen in Table 7. This result states that there is a positive strong relation between the gross value added and the tractor motor power per 100 ha in Turkey sample statistically. When we look at the numbers of tractor in Table 4 and proportion them to agricultural arable areas we see that tractor existence of Turkey rose up to 5.9 pcs per 100 ha from 5.1 pcs per 100 ha between 2010–2013. It means there is nearly 16% increase in tractor existence per 100 ha. When we see the positive correlation, it can be linked with this situation. Performing some studies by producing more data from field will be important for reaching this result more correctly. But in the hypothesis control given in equations (2) and (3), t table value in n – 2 freedom

TABLE 7. Correlation table for Turkey's data

×	Indicator	GVA	Level of agricultural mechanization
GVA*	Pearson correlation	1	.921
	Significance (2-tailed)		.25
	N	3	3
Mechanization	Pearson correlation	.921	1
	Significance (2-tailed)	.25	–
	N	3	3

* Gross value added.

degrees and $\alpha = 0.05$ significance level is found as 12.7. As t-statistics value (t) is calculated as 3.9 via equation (5) and it is less than t theoretical (12.7), it should be taken into consideration that this positive strong relation might be coincidental.

When the same evaluation was done for Poland's data in Table 6, Pearson correlation coefficient was calculated as 0.8 via equation (1) and the correlation table can be seen in Table 8. This result states that there is also a positive strong relation between the gross value added and the tractor motor power per 100 ha in Poland sample. When we look at the numbers of tractor in Table 4 and proportion them to agricultural arable areas we see that tractor existence of Poland rose up from 9.8 pcs per 100 ha to 10 pcs per 100 ha between 2010–2013. It means there is 2% increase in tractor existence per 100 ha. When we see the positive correlation, it can be linked with this situation like in Turkey's data. But in the hypothesis control given in equations (2) and (3), t table value in $n - 2$ freedom degrees and $\alpha = 0.05$ significance level is found as 12.7. As t-statistics value (t) is calculated as 1.4 via equation (5) and it is less than t theoretical (12.7), it should be taken into consideration that this positive strong relation might be coincidental.

Pearson correlation analysis for Turkey's data in Table 5 was done in order to determine the relation between the tractor motor power per 100 hectare and share of agricultural employment in total employment [%] and Pearson

TABLE 8. Correlation table for Poland's data

×	Indicator	GVA	Level of agricultural mechanization
GVA*	Pearson correlation	1	.820
	Significance (2-tailed)		.387
	N	3	3
Mechanization	Pearson correlation	.820	1
	Significance (2-tailed)	.387	–
	N	3	3

* Gross value added.

TABLE 9. Correlation table for Turkey's data

×	Indicator	Level of agricultural mechanization	Agricultural employment rate
Mechanization	Pearson correlation	1	–.985
	Significance (2-tailed)		.10
	N	3	3
Employment rate	Pearson correlation	–.985	1
	Significance (2-tailed)	.10	–
	N	3	3

correlation coefficient was calculated as –0.9 via equation 1 and the correlation table can be seen in Table 9. The expected decrease in agricultural employment rate against the increase in agricultural mechanization level can be seen and it shows that there is an important impact of increase in agricultural mechanization level in agricultural employment. But in the hypothesis control given in equation 2 and 3, t table value in $n - 2$ freedom degrees and $\alpha = 0.05$ significance level is found as 12.7. As t-statistics value (t) is calculated as 4.9 via equation (5) and it is less than t theoretical (12.7), it should be taken into consideration that this negative strong relation might be coincidental.

When the same evaluation was done for Poland's data in Table 6, Pearson correlation coefficient was calculated as –0.6 via equation (1) and the correlation table can be seen in Table 10. This result states that there is a negative strong relation between the tractor motor power per 100 ha and share of agricultural employment in total employment in Poland sample as expected. But in the hypothesis control given in equations (2) and (3), t table value in $n - 2$ freedom degrees and $\alpha = 0.05$ significance level is found as 12.7. As t-statistics value (t) is calculated as 0.9 via equation (5) and it is less than t theoretical (12.7), it should be taken into consideration that this negative strong relation might be coincidental.

TABLE 10. Correlation table for Poland's data

×	Indicator	Level of agricultural mechanization	Agricultural employment rate
Mechanization	Pearson correlation	1	–.683
	Significance (2-tailed)		.521
	N	3	3
Employment rate	Pearson correlation	–.683	1
	Significance (2-tailed)	.521	–
	N	3	3

CONCLUSIONS

It has been seen from the findings that agricultural gross value added shows increase while agricultural mechanization level increases according to both countries' data. Share of agricultural employment in total employment has shown decrease while agricultural mechanization level increases as expected. These results can be evaluated as a consequence of correct strategies in managing agricultural mechanization but it should be traced via control of regular statistics. It will be important to determine if agricultural mechanization level is in accord with average field area and equipment size with more data from field statistically in terms of composing and maintaining right politics in agricultural mechanization.

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Streszczenie: *Struktura rolnictwa w Polsce i Turcji jako przesłanka analizy poziomu mechanizacji rolnictwa z uwzględnieniem porównawczych metod statystycznych.* Sektor rolniczy odgrywa ważną rolę w gospodarce każdego kraju, gdyż zaspokaja rosnące potrzeby żywnościowe ludności, dostarcza surowce dla przemysłu i umożliwia tworzenie miejsc pracy na obszarach wiejskich. Znaczenie rolnictwa w strukturach społecznej i gospodarczej Turcji systematycznie wzrasta ze względu na jej odpowiednie położenie geograficzne i sprzyjające warunki klimatyczne. Istotne jest optymalne wykorzystanie maszyn i sprzętu rolniczego w dobie wzrastających kosztów eksploatacji, rosnących cen energii oraz w celu zapewnienia rentowności produkcji rolnej. W artykule autorzy analizują stopień mechanizacji rolnictwa w Polsce i Turcji z wykorzystaniem narzędzi statystycznych. Badania przeprowadzono metodą desk research i ukierunkowano je na określenie poziomu mechanizacji rolnictwa w obu krajach, które mają podobną strukturę gospodarstw rolnych oraz porównywalny stopień wykorzystania maszyn i urządzeń rolniczych. Badania te są istotne, ponieważ pozwalają również na przeanalizowanie makrootoczenia i umożliwiają tworzenie strategii rozwoju w sektorze rolniczym.

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